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BIRMINGHAM



# The Groundwater Drought Initiative (GDI):

## Analysis of European groundwater drought

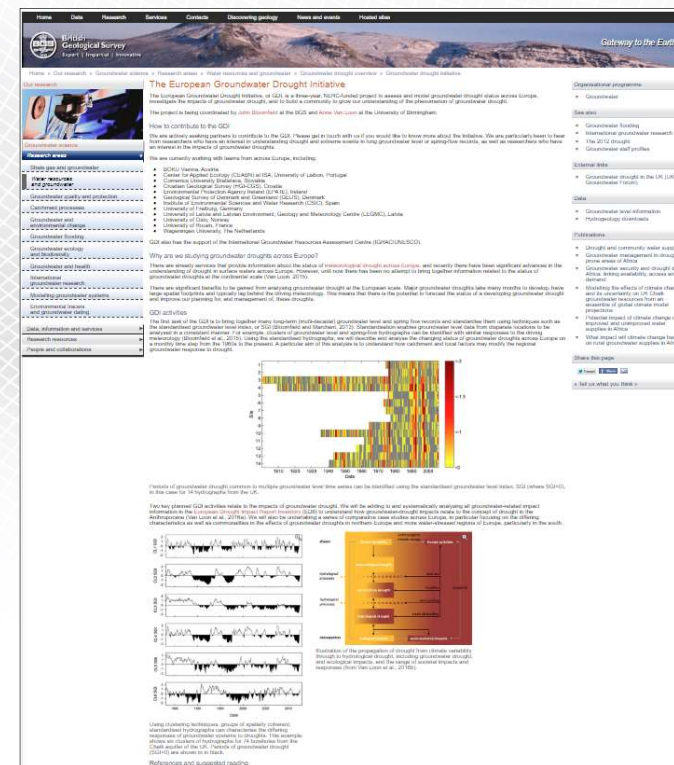
Bentje Brauns<sup>1</sup>, John P. Bloomfield<sup>1</sup>, Daniela Cuba<sup>2</sup>, David M. Hannah<sup>3</sup>, Christopher R. Jackson<sup>2</sup>,  
Benedikt Heudorfer<sup>3</sup>, Ben P. Marchant<sup>2</sup>, Anne Van Loon<sup>3</sup>



# Overview of the GDI (2018-2021)



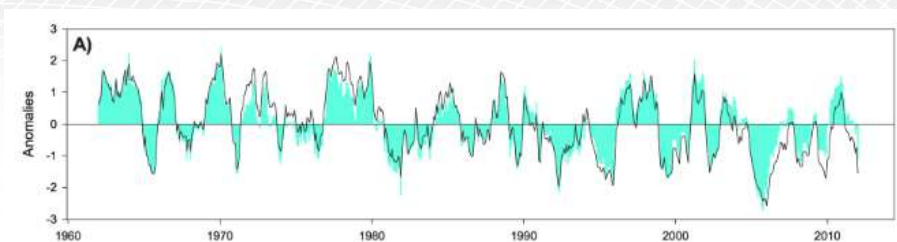
- Why
- What
- How
- Expected outputs





## Why are we interested in pan-European groundwater events?

- Good overview of European meteorological and surface water drought
- Missing equivalent for groundwater drought



Vicente-Serrano et. al, 2014, Environmental Research Letters (SPI and SPEI time series shown in plot)

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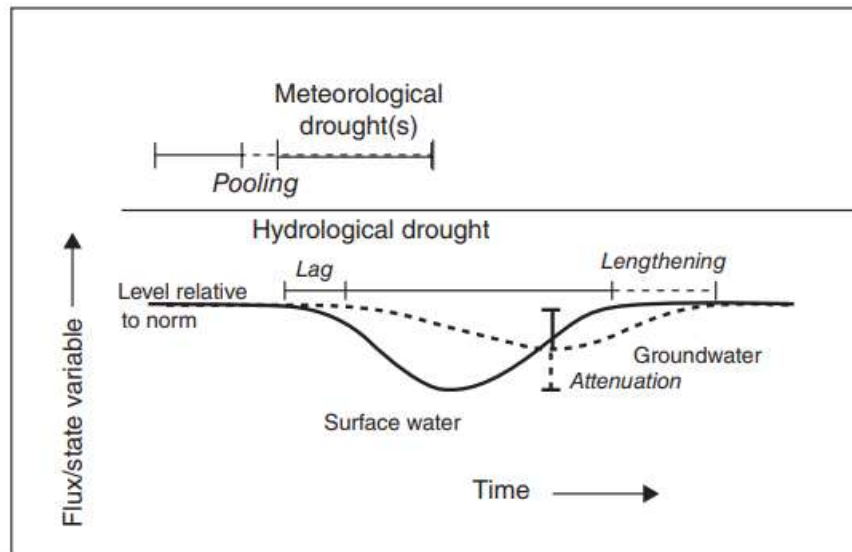




# WHY

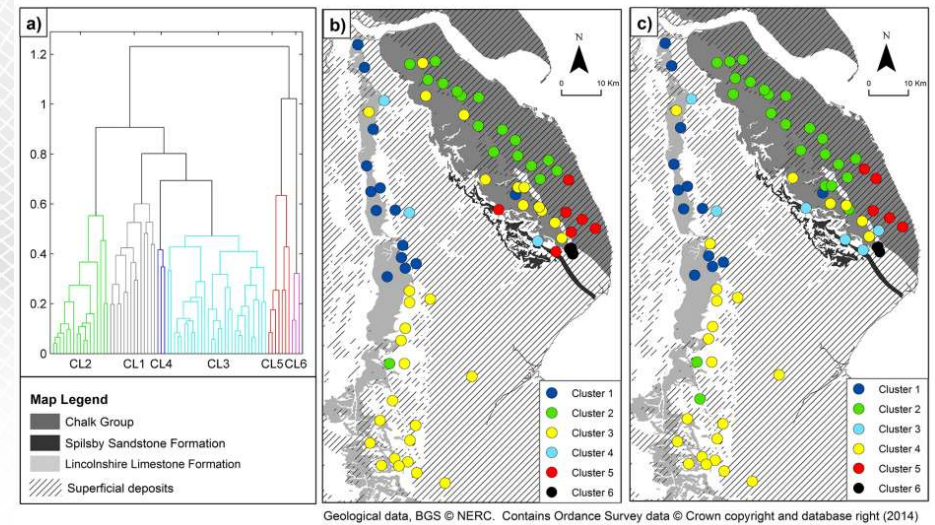
## Specific characteristics of groundwater droughts

### Pooling, lagging & lengthening



Van Loon AF. 2015. Hydrological drought explained. WIREs Water, 2, 359–392

### Geospatial distribution



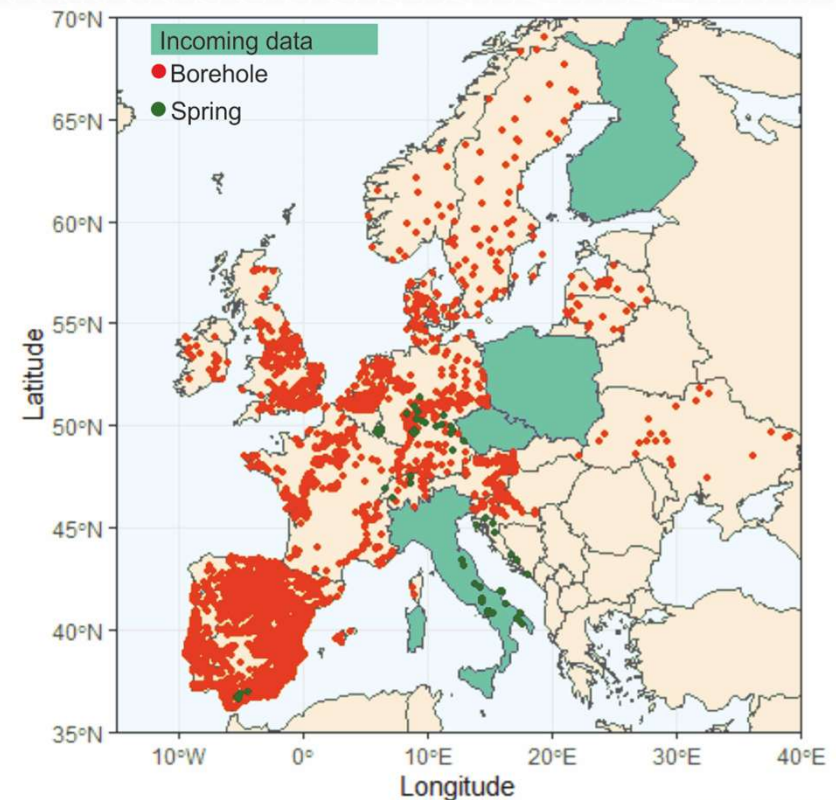
Bloomfield et al. 2015. Regional analysis of groundwater droughts using hydrograph classification. HESS, 19, 4327–4344.



# WHAT

## Pan-European groundwater level analysis

- Collecting groundwater data
- Standardise (SGI) & analyse (scripts, shiny app)
- Clustering data to identify spatial patterns
- Case studies to understand the relationships between groundwater droughts and their societal impacts



European Drought Centre

WAGENINGEN  
UNIVERSITY & RESEARCH

friend

BOU  
University of Natural Resources  
and Life Sciences, Vienna

igrac  
International Groundwater Resources Assessment Centre

CSIC  
CONSEJO SUPERIOR DE INVESTIGACIONES CIENTÍFICAS

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NORMANDIE

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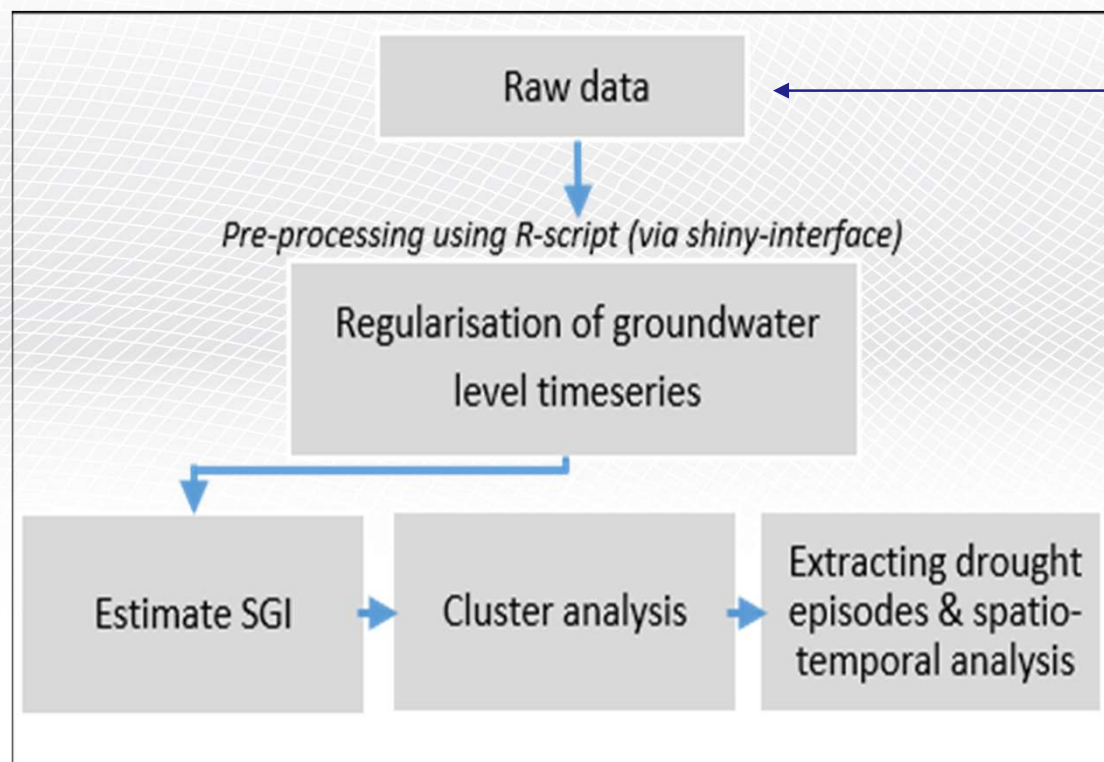
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GDI



Mapping  
groundwater  
drought  
across Europe

## HOW Analysis approach



Data input:

- Up to ~100 sites/country
- Long time series (~30 yrs)
- Monthly data
- Unconfined aquifers
- Little anthropogenic influence

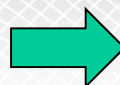
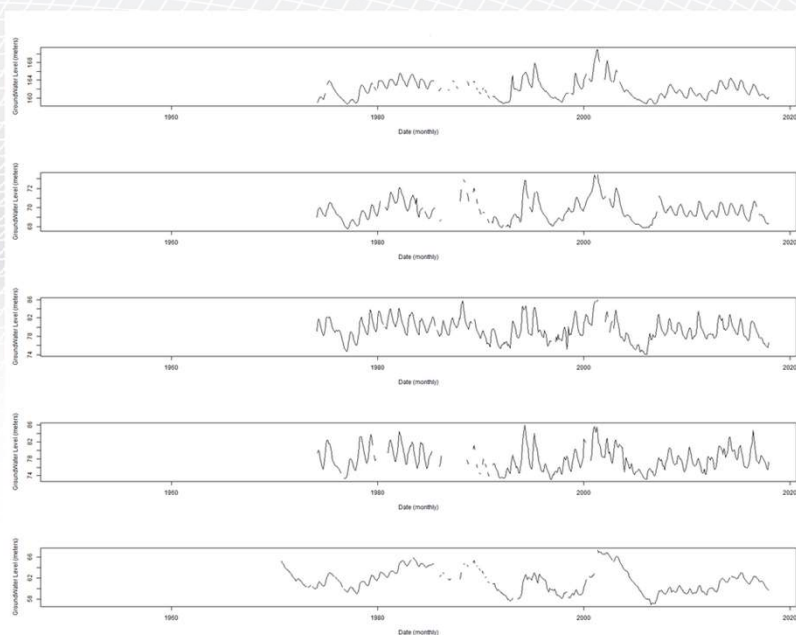




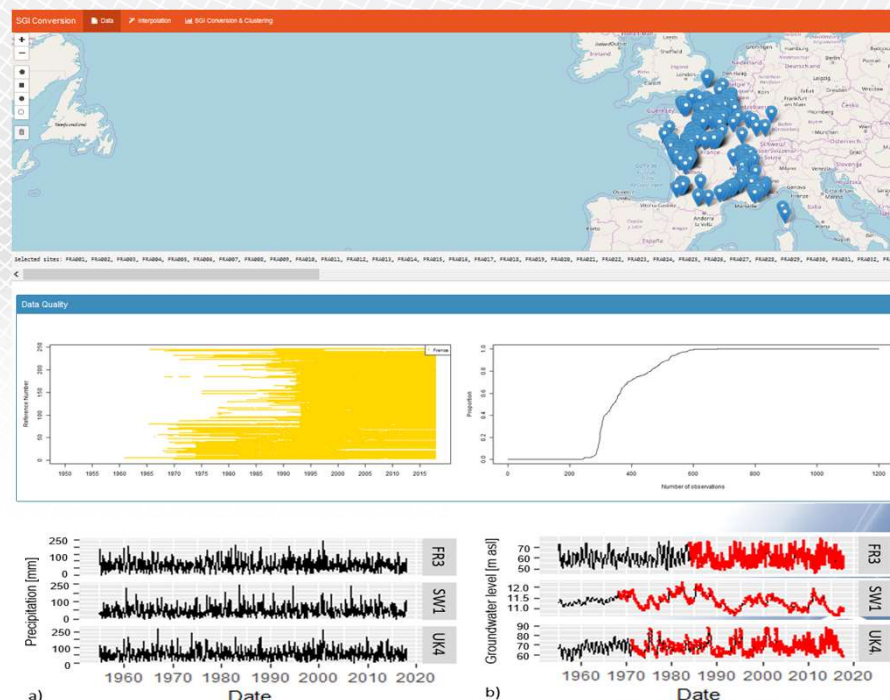
# HOW

## Raw data and regularisation

### Raw data



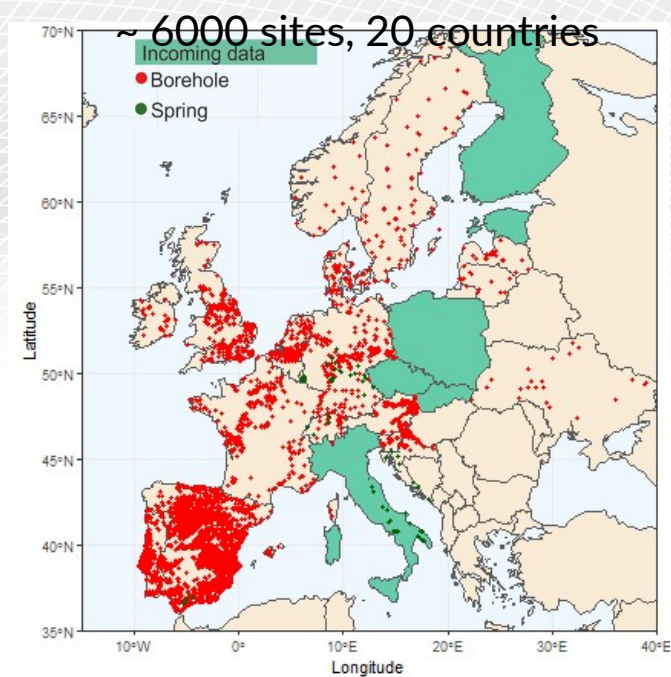
### Pre-processing & regularisation



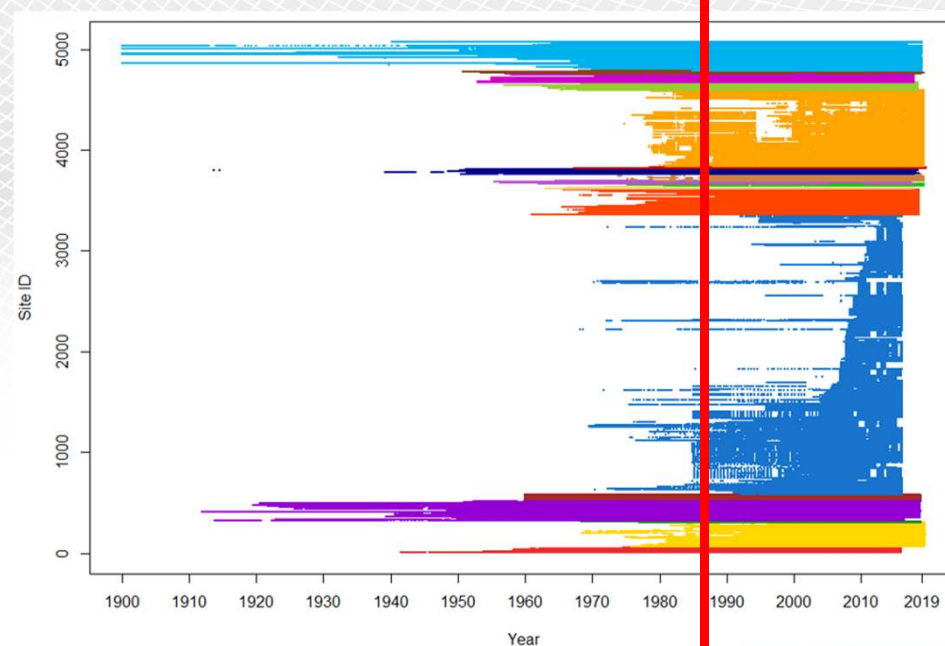


## (preliminary) OUTPUT Data selection

### Obtained data set (working status)



### Time series' lengths and data quality

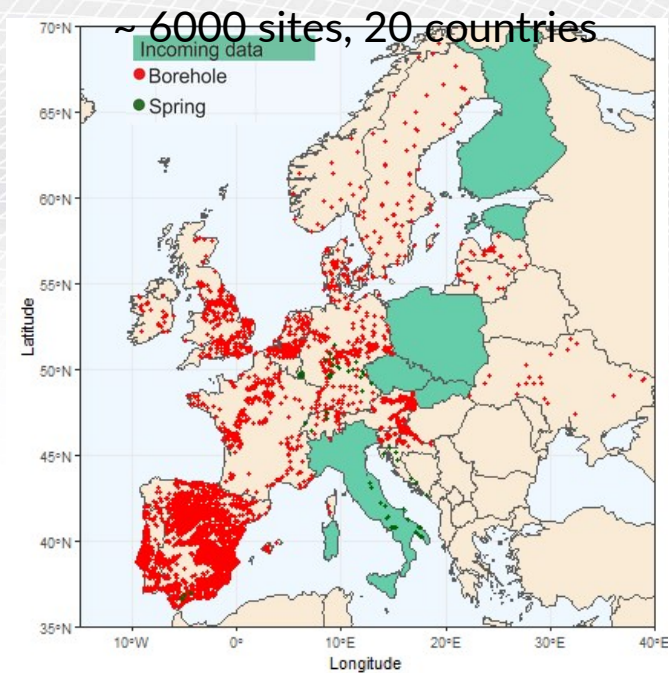




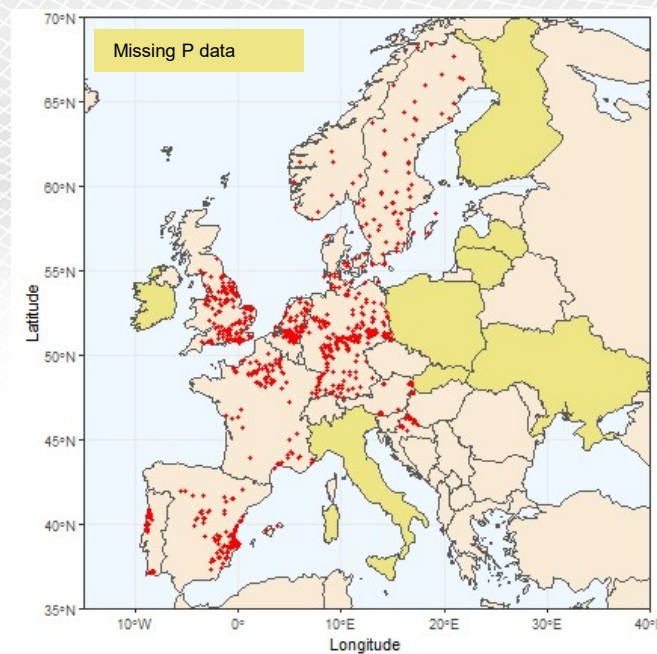


## (preliminary) OUTPUT Data selection

Obtained data set (working status)

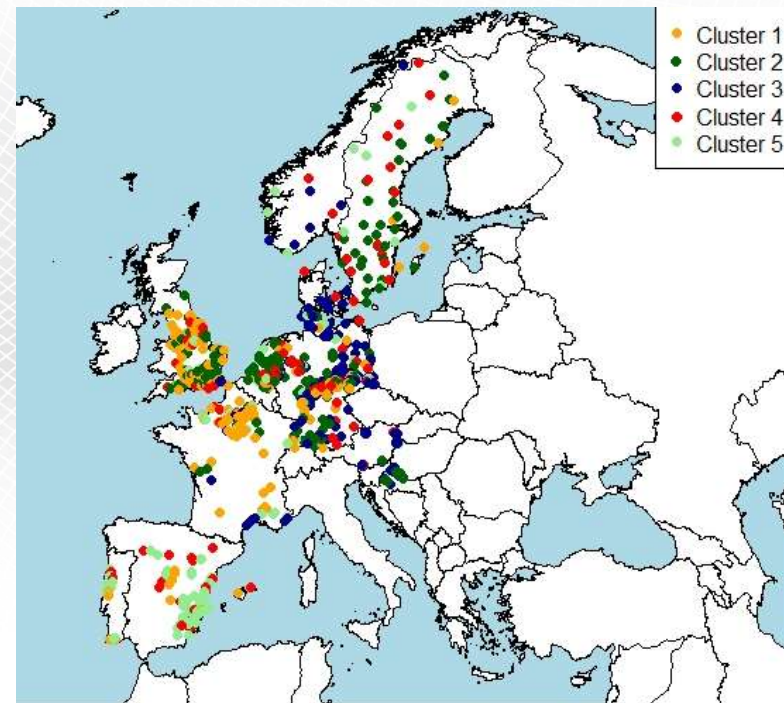
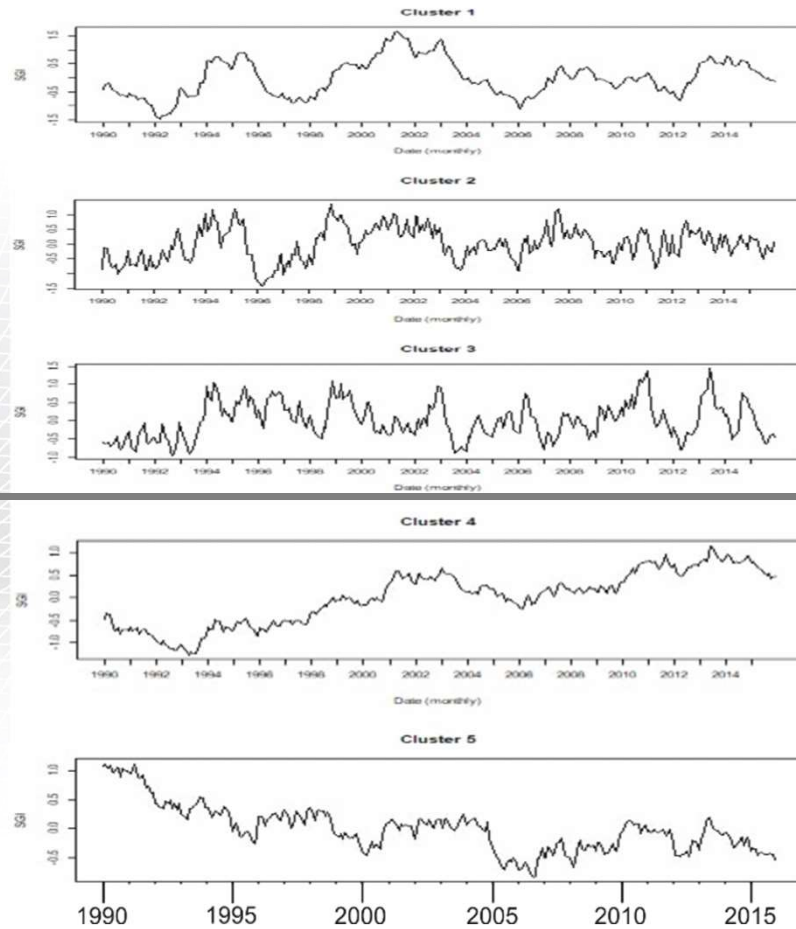


Subsetted dataset for prelim. analysis  
~850 sites, 12 countries



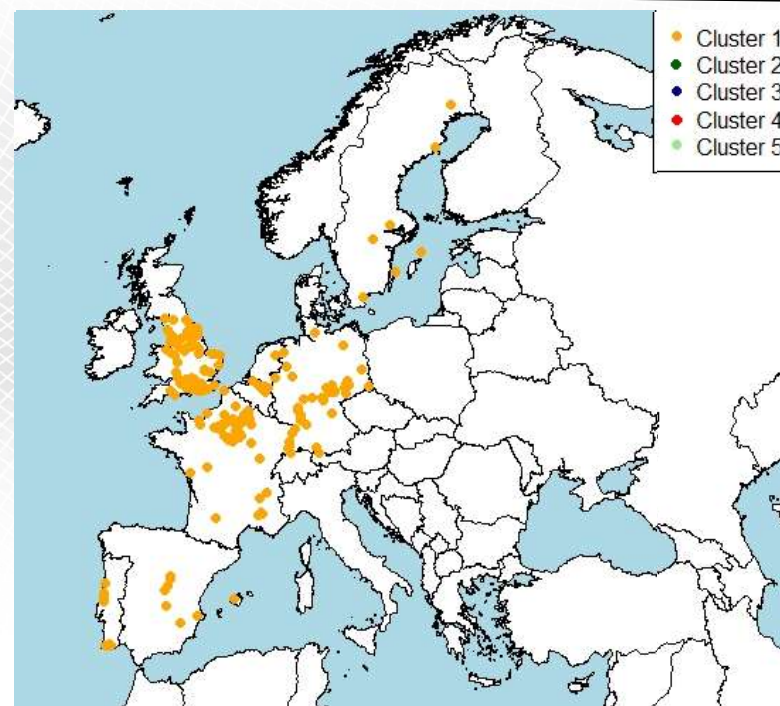
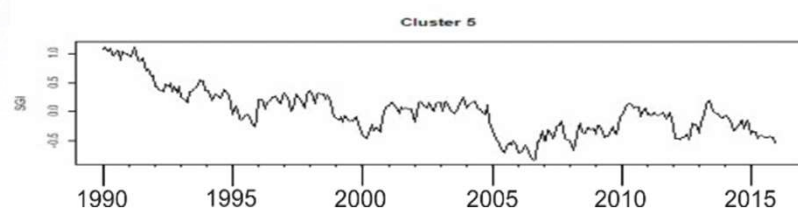
## (preliminary) OUTPUT

### Processed data



## (preliminary) OUTPUT

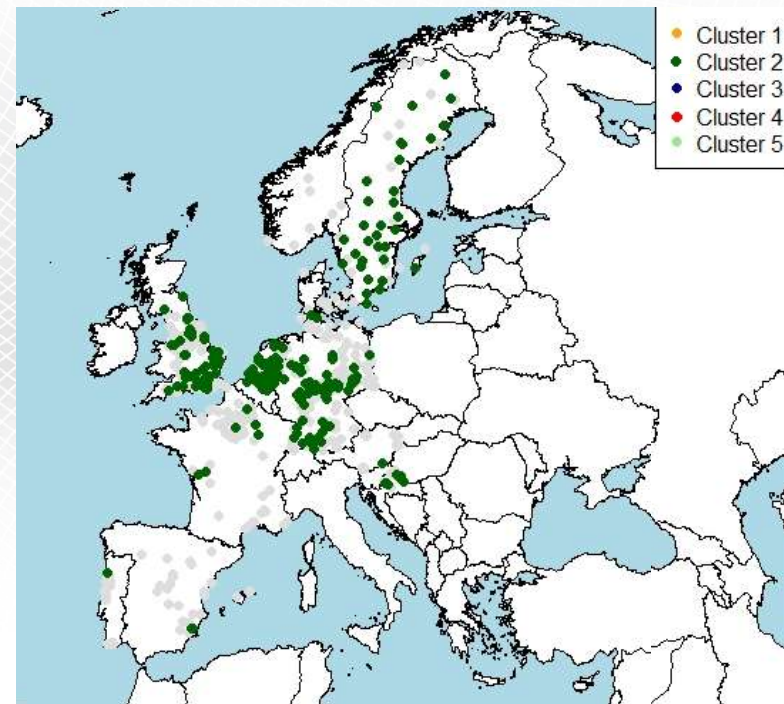
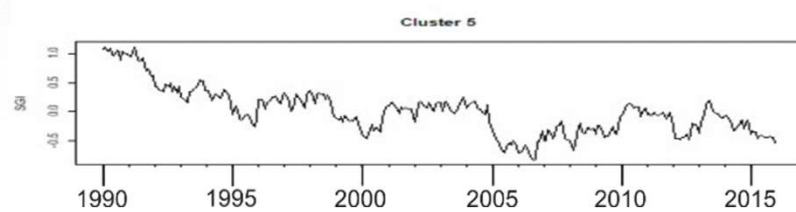
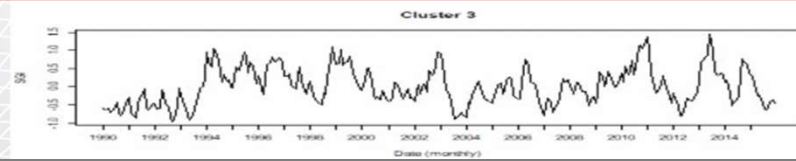
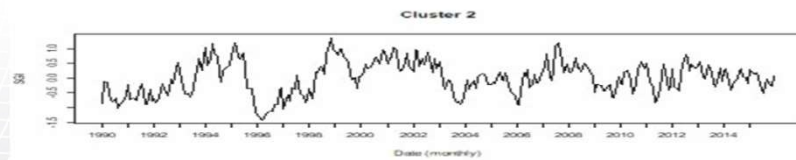
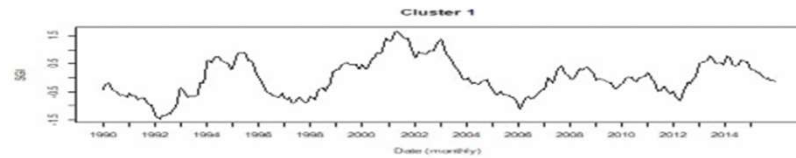
### Processed data





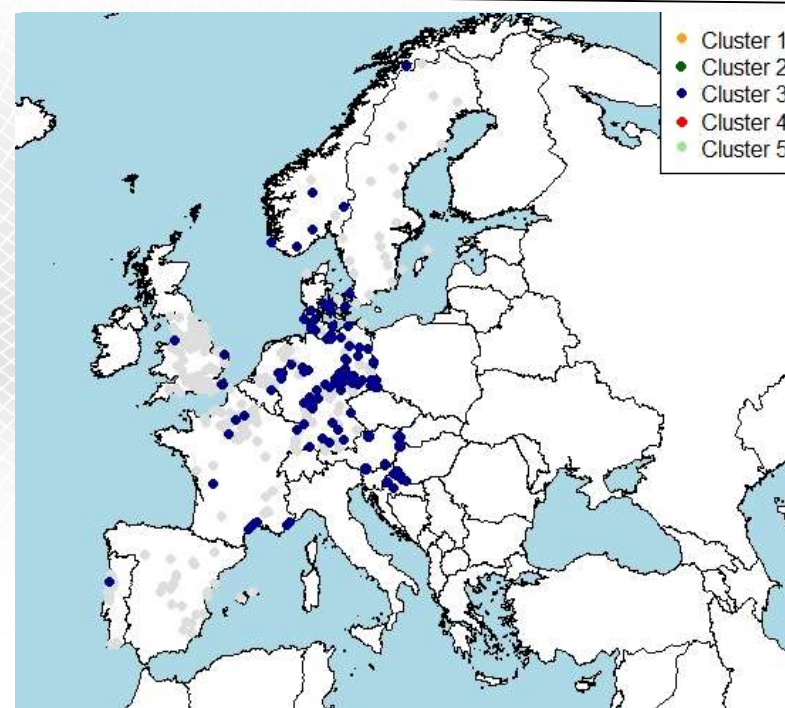
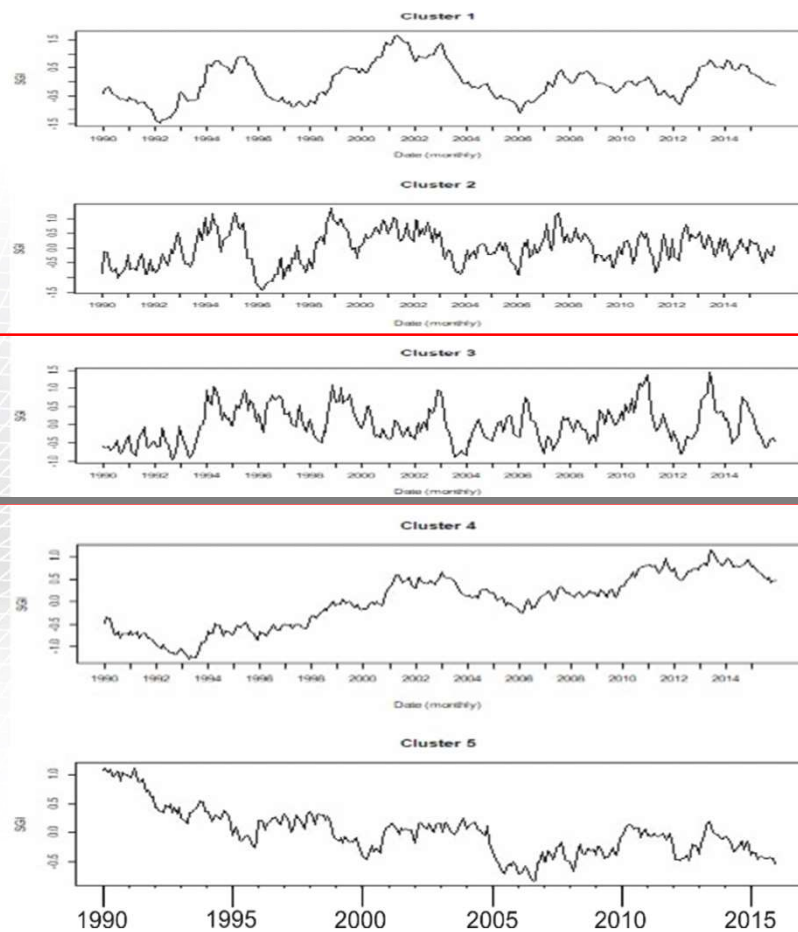
## (preliminary) OUTPUT

### Processed data



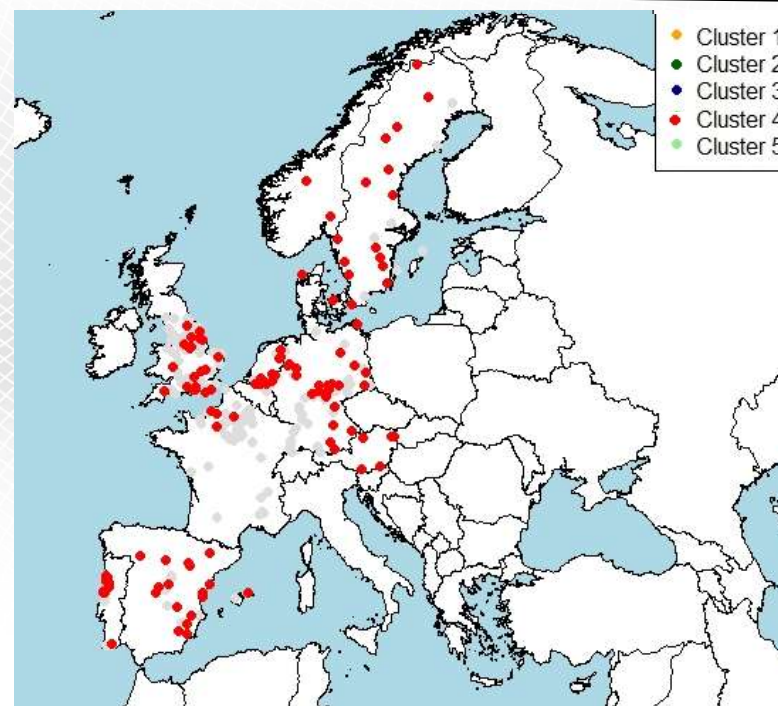
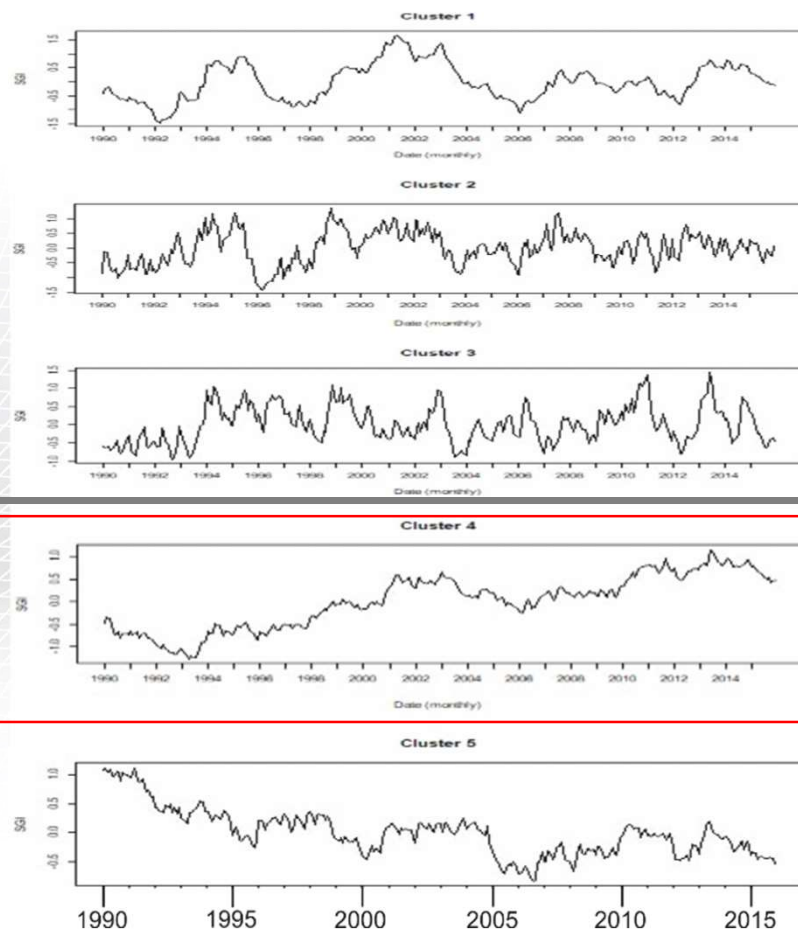
## (preliminary) OUTPUT

### Processed data



## (preliminary) OUTPUT

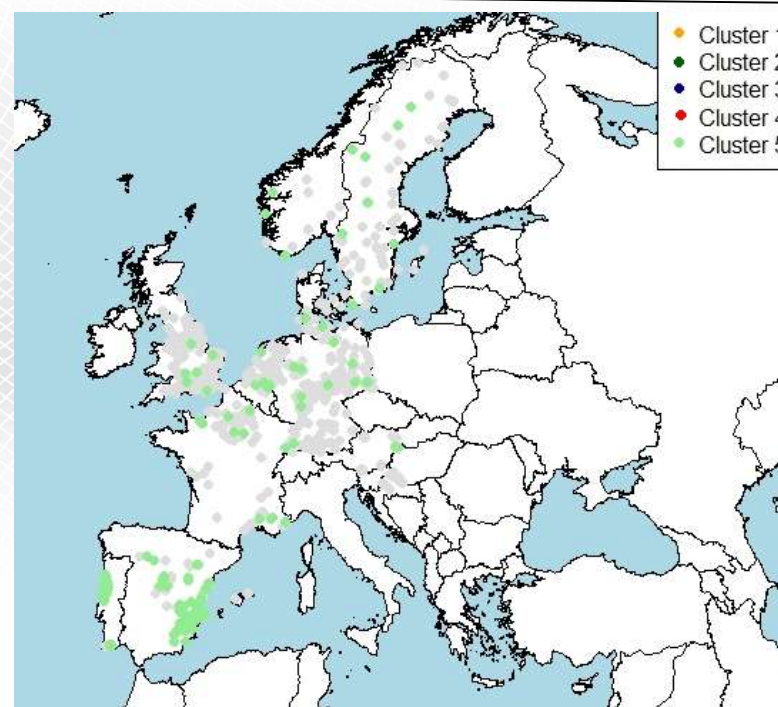
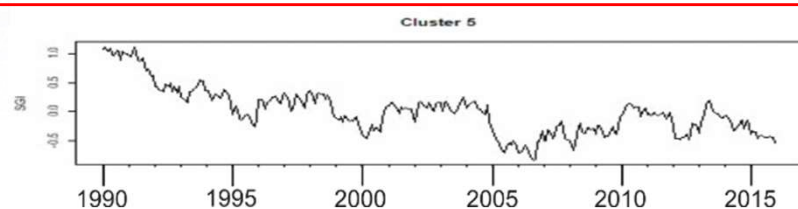
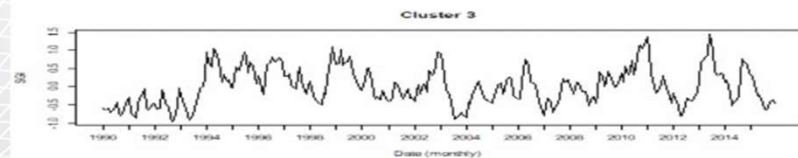
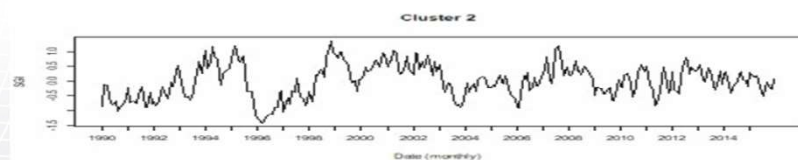
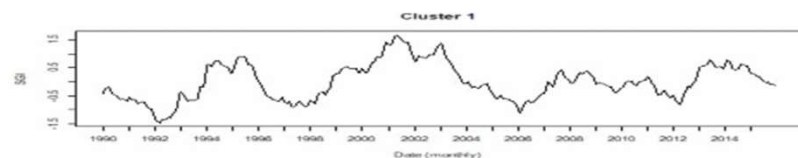
### Processed data





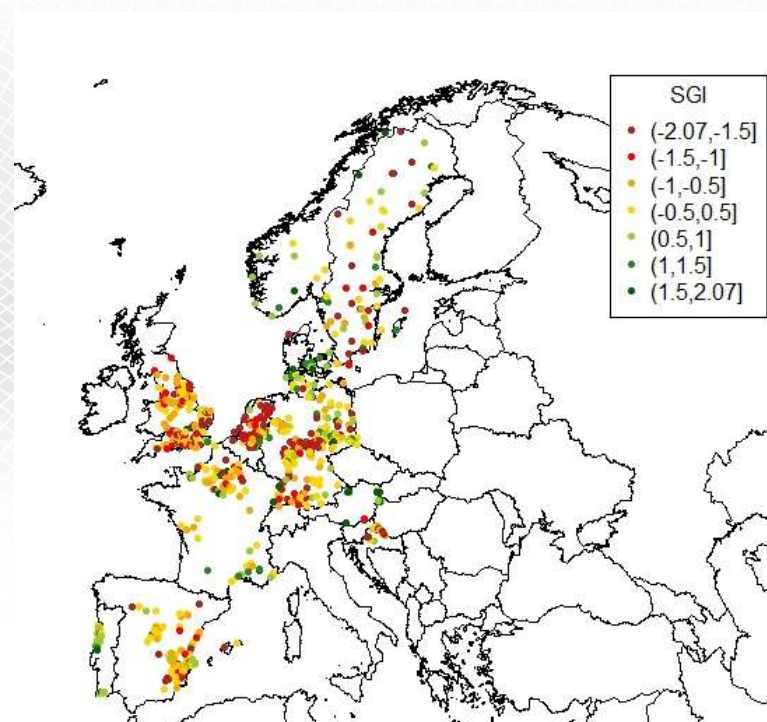
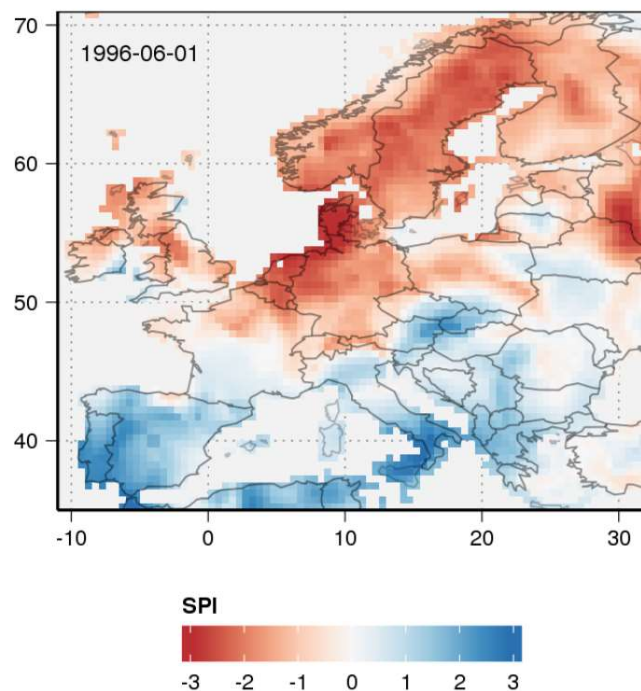
## (preliminary) OUTPUT

### Processed data





# (preliminary) OUTPUT Processed data



European drought centre, <http://www.geo.uio.no/edc/droughtdb/edr/spidates.php>

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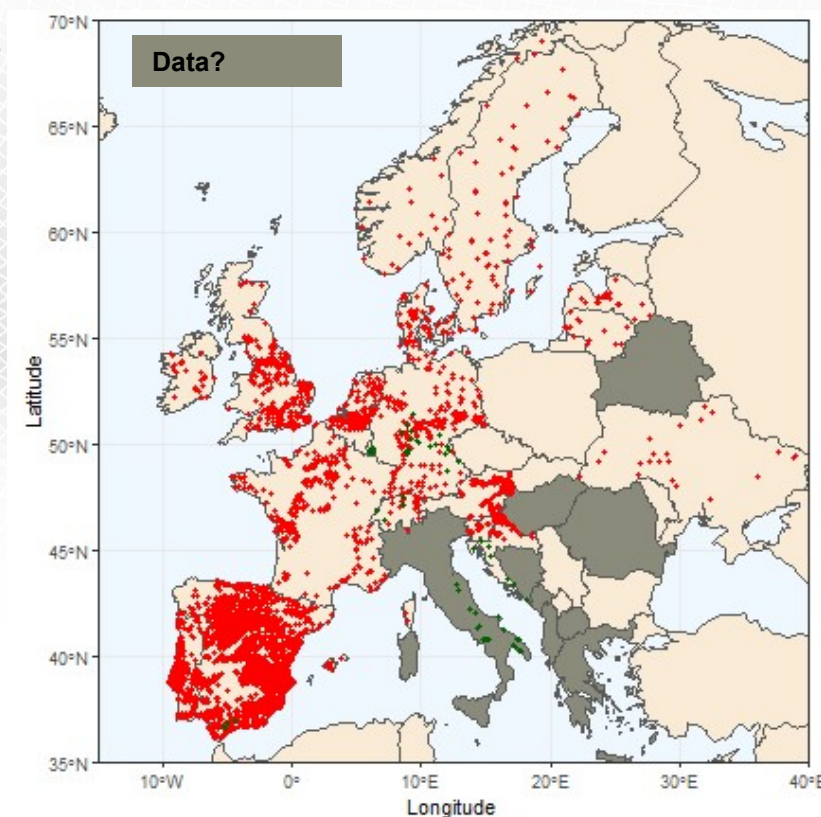
## Summary and further work

A very first look at processed data seems to indicate meaningful spatial coherence

### Ongoing work

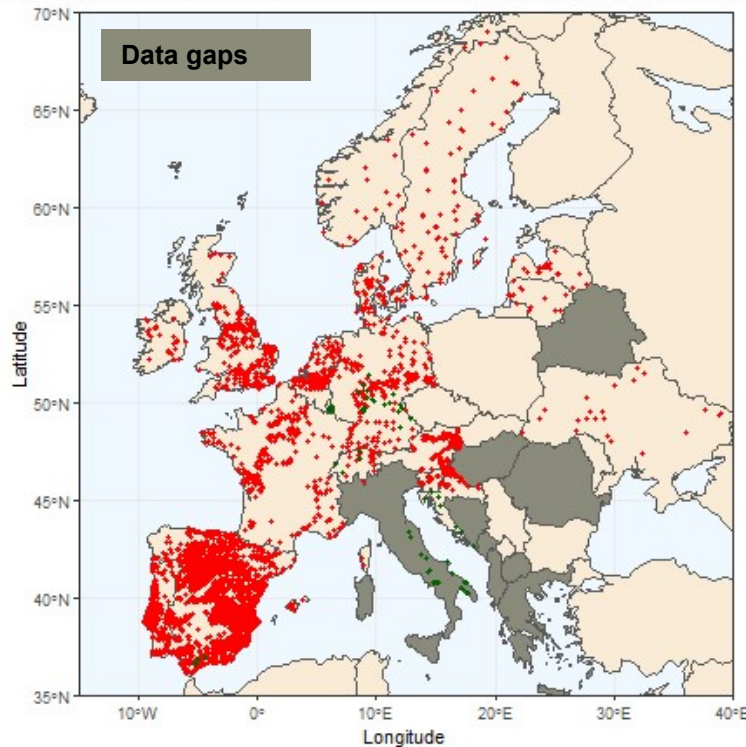
- Add to existing dataset
- Improve data selection
- Fine-tune analysis (e.g. clustering)
- Add temperature data
- Analyse spatially with respect to controlling factors and include statistical analysis
- Compare to existing review of met. and surface water drought
- Increase network activities (meeting next year)

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**Thank you for you attention and questions are very welcome!**



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**Please get involved!**

**Benefits:**


- access to scripts
- discussions about data
- joint workshops / groundwater drought conference
- building a network of groundwater drought researchers
- joint publications



**Special thanks for providing data and expertise to:**

|              |  |
|--------------|--|
| Austria:     | Federal Ministry for Sustainability and Tourism (BMNT), and guidance from University of Graz, Geological Survey Austria and BOKU Vienna  |
| Belgium:     | Flanders Environment Agency (VMM)  |
| Croatia:     | Croatian Geological Survey (HGI-CGS)   |
| Czech Rep.:  | Czech Hydrometeorological Institute (CHMI)   |
| Denmark:     | Geological Survey of Denmark and Greenland (GEUS)  |
| Estonia:     | Geological Survey of Estonia (EGT)   |
| Finland:     | Finnish Environment Institute (SYKE)   |
| France:      | Geological Survey of France (BRGM) and University of Rouen   |
| Germany:     | Federal State Agencies of Bavaria, Brandenburg, Baden-Württemberg, Hesse, Lower Saxony, North Rhine-Westphalia, Saxony, Saxony-Anhalt, Schleswig-Holstein, Thuringia, University of Freiburg |
| Ireland:     | Environmental Protection Agency Ireland (EPA IE)   |
| Italy:       | University of Salerno, Water Research Institute (CNR-IRSA)   |
| Latvia:      | University of Latvia and Latvian Environment, Geology and Meteorology Centre (LEGMC)   |
| Lithuania:   | Nature Research Centre, Lithuania  |
| Luxembourg:  | Luxembourg Institute of Science and Technology (LIST)  |
| Netherlands: | Netherlands Organisation for Applied Scientific Research (TNO), Wageningen University  |
| Norway:      | The Norwegian Water Resources and Energy Directorate (NVE), University of Oslo   |
| Portugal:    | Centre for Applied Ecology (CEABN) at ISA, University of Lisbon  |
| Slovakia:    | Slovak Hydrometeorological Institute (SHMU), Comenius University Bratislava  |
| Slovenia:    | Slovenian Environment Agency (ARSO)  |
| Spain:       | Institute of Environmental Sciences and Water Research (CSIC)  |
| Sweden:      | Geological Survey of Sweden (SGU)  |
| Switzerland: | Federal Office for the Environment FEON  |
| Ukraine:     | Ukrainian Hydrometeorological Institute UHMI   |

[www.bgs.ac.uk/groundwaterDrought](http://www.bgs.ac.uk/groundwaterDrought)

 @GDI\_Europe

Chair of Hydrological Modelling and Water Resources at Freiburg University / WokaS database (global karst spring discharge datasets)

